

from the 8th to the 12th of April, in a parabolic orbit. With the period assigned by Burckhardt, the comet would have passed its aphelion in October or November 1763, at which time the planet Jupiter was near the same heliocentric longitude, and his distance from the comet might have been less than 0.4; indeed, a period very slightly shorter than Burckhardt's, and quite within the probable error of his determination, might have occasioned an extremely close approach of the two bodies, producing, in all probability, a great alteration of elements, and resulting in the ellipse of short period indicated by the observations of 1766. This comet was suspected by Clausen to have been identical with the comet of July 1819, or the comet of Winnecke, which has been observed during the present year; and the very possible close approach to the planet Jupiter in the autumn of 1763 may have been the cause of the introduction of this body amongst the quickly revolving comets of the system. It is also to be remarked that Burckhardt's orbit for 1766 points to a close approximation to the orbit of Mercury; in about heliocentric longitude 290° , the distance is less than 0.025.

THE SOLAR ECLIPSE

IN continuation of our articles on this subject, we print the following telegrams which have since been received, detailing the results of the observations; together with some remarks which have appeared in the *Times* concerning them.

First, with regard to the Siam party we have, from Singapore, April 15, the following Reuter's telegram with respect to the results obtained:—

"Valuable results were obtained by the English observers of the solar eclipse in Siam. Although the sky was hazy, the results by the prismatic camera were good. The spectroscopic cameras failed. Eight good photographs of the corona were taken."

Next, a *Times* telegram from Dr. Schuster, at Bangkok, as follows:—

"The English observers of the solar eclipse in Siam are remaining a few days at their station to take copies of photographs obtained. Unavoidable accidents prevented them being on the spot until five days before the eclipse. Owing to the untiring energy of Capt. Loftus, the arrangements were nearly complete, and thus partial success of the expedition secured."

Next, a *Daily News* telegram from the special correspondent of that journal with the expedition at Bangkok:—

"The results of the English Eclipse Expedition must be considered merely preliminary, this being the first time spectrum photography has been tried. The prismatic camera shows the rings with protuberances at the edge of the sun, and at least one more ring towards the ultra-violet without protuberances. Eight good photographs of the corona were taken, the exposure varying from two to sixteen seconds."

It will be observed that in none of these telegrams was Dr. Janssen mentioned. It is possible, therefore, that he left Singapore before the arrival of the English Expedition. Be this as it may, he observed the eclipse in Siam, and on Monday last, at the Paris Academy of Sciences, a telegram was read from him to the effect that though the sky was not clear, he obtained results, and that these were confirmatory of those obtained in 1871, so far as they related to the coronal atmosphere.

The news received from the Camorta party is a sad contrast to the above. The following Reuter's telegram, dated "Calcutta, April 18," will no doubt cause universal regret:—

"The Indian astronomical party at Camorta were successful in observing the external contacts during the solar eclipse. They failed, however, to obtain photo-

graphic results, owing to the sky being completely overcast during totality."

The *Times*' comments on the results obtained at Siam are as follows:—

"Reading the above telegram from Dr. Schuster in connection with that which we published in our second edition on Wednesday last (*NATURE*, April 15, p. 474), we see that two-thirds of the work which the Siam expedition went out to do have been successfully accomplished. Photographs giving us the actual shape and many of the conditions of the coronal atmosphere at the present epoch of minimum sun-spots have been secured, and these photographs we shall be able to compare with those taken in India and Java in 1871 at the time of maximum sun-spots. It is not too much to hope that this comparison may teach us much as to the changes in the solar atmosphere which accompany or are brought about by the changes in the spots—changes which require eleven years or thereabout to run through their cycle. But this, after all, is a trifle compared with another part of the work. Not only was photography *pure et simple* employed to tell us the shape and other conditions of the solar atmosphere, but photography *plus* spectroscopy has been utilised to tell us the chemical constitution of the various readings of the sun's surroundings; and it is in this branch of the work that the most valuable of the announced results have been obtained. The Committee of the Royal Society laid so much stress upon this part of the attack that no less than three instruments were devoted to it by the Siam party alone, the work of each being so arranged that it would supplement that accomplished by any of the others.

"A few simple considerations will serve to indicate not only the nature of this part of the work, but how carefully it had been prepared throughout by those upon whom the responsibility of organising the expeditions fell. The brilliancy of the corona has varied enormously—one, indeed, might almost say impossibly—in various eclipses. The celebrated Otto Struve, for instance, has placed on record the fact that in one of the eclipses which he observed its brilliancy was almost insupportable to the naked eye; other astronomers have made use of expressions equally strong, while it is known that, if those who are fortunate enough to have the opportunity of observing eclipses take the precaution of guarding the eye from the direct light of the sun before its disappearance, there is not only light enough from the corona to read by with comfort, but a light surpassing in brilliancy the brightest moonlight we are familiar with in these latitudes. This is so far as the eye is concerned. When we deal with the photographic plate instead of the retina, the brilliancy of the corona becomes yet more certain. A camera of, say, four inches aperture will impress an image of the corona on a prepared plate in far less time than it will impress an image of the moon at its brightest. This is one indication of the photographic brilliancy of the coronal light, and in a former article we took occasion to refer to others of an equally striking kind which were rendered very obvious during the eclipse of 1871. The evidence as to the brightness of the spectrum of the lower layers of the sun's atmosphere is equally strong."

"The Royal Society Committee, therefore, would have been justified in reckoning upon a bright corona. They did so, but at the same time they provided for a very feeble one. Long before the expedition sailed, the members of both parties made some very interesting researches on the possibility of securing photographs of gaseous spectra—that is, precisely such spectra as those which it is natural to expect will be furnished to us by the corona. They found that, with a time of exposure only slightly in excess of that allowed by the eclipse itself, they were enabled to photograph the spectra of chlorine, nitrogen, and other similar bodies under somewhat complicated instrumental conditions, and when those spectra

were dimmer than the spectrum of the corona is known to be."

The extreme importance which attaches to the determination of the particular class of spectrum under which that of the corona may be classed was pointed out in NATURE, vol. xi. p. 201, and on this point the *Times* article says:—

"The most perfect determination would have been accomplished when the peculiarities of the spectrum, of whatever class it might be, with its bright lines or its 'channelled spaces,' had been recorded over a long range. For this purpose the Siam party was provided with a siderostat, a short focus reflector, and a spectroscopic camera of long focus—that is, a spectroscope in which the ordinary observing telescope had been replaced by a lens of long focus and a photographic camera. If everything had been in order, the air perfectly clear, and the corona very bright, this instrument would have given us the most valuable record of all, as we should have obtained a detailed spectrum of the coronal atmosphere and chromosphere from the Fraunhofer line G to far beyond H, the ordinary limit of visibility. This was the most crucial experiment; while it was the one least likely to be realised, its success would have been of the highest importance, as the chemical as well as the physical constitution might have been more or less fully revealed. Next in delicacy to this came a similar arrangement in which the same principles were depended on, but in which, as all the parts were not of quartz and as the focal length of the camera was not so great, equally good results over so large a range were not to be dreamt of. The nature of the spectrum and of some of the constituent gases of the solar atmosphere might have been determined in this way, but the information, though equal in quality to that obtained by the instrument to which we have before referred, would have been deficient in quantity. Still, this information might have been obtained with a less clear air and by less brilliancy in the corona than were necessary for perfect success in the former case.

"In the prismatic camera, an instrument described at some length in our last article (reprinted in NATURE, vol. xi. p. 452), we have an instrument which may be held to be certain to give us a valuable result, even if the air be not very clear and if the corona be not very bright. We may say that this was the gross attack upon the chemical nature of the corona, as the siderostat and its accompanying long-focus spectroscope represented the most delicate one. Now this has perfectly succeeded, and in this lies the extreme importance of the observations made in Siam. For some reason which is not yet clear to us, the more delicate ones have failed. On receipt of the first telegram we attributed this failure to the hazy sky, which would as certainly have cut off all the violet rays which alone were to be impressed on the photographic plate as the blue rays are cut off at sunrise, giving us, as the result of the absorption of all the blue light, first the rosy-fingered dawn and then the red sun himself. But from Dr. Schuster's later telegram which we have now received it would appear that some accident had delayed the colonial steamer between Singapore and Siam, and, further, that the observatories which it was hoped would have been built at Chulai Point before the expedition arrived at Singapore had never been built at all; so that the expedition had to proceed direct to Bangkok, and, as an inevitable consequence, spent in royal receptions the time which was absolutely required for the erection and adjustment of the instruments, with or without observatories over them.

"Where and how the delay of four days occurred will, of course, be known hereafter, and it is needless to speculate too closely upon it; but it is clear that Dr. Schuster is inclined to attribute the incompleteness of the results which his party has attained more to this delay than even

to the haze. We can well imagine his disappointment in not having the whole story to tell; but the measure of success his party has achieved is greater than might fairly have been expected from any one expedition, and there is little doubt that the photographs his party has secured will do more to advance solar physics than any permanent records obtained by any former expedition. They are well worth all the time, labour, and thought which have been lavished on the whole attempt.

"Evidence of the highest value bearing on the general nature of the spectrum of the coronal atmosphere in the blue region has been obtained. It was clear that the minimum of success must enable us to compare the coronal atmosphere as a whole with that part of it which is composed mainly of hydrogen, and if there happened to be a remainder, the chemical nature of that remainder would be demonstrated. Let us explain the sense in which we have used the term 'remainder.' Evidence was collected during the eclipse of 1871 which went to show that above the hydrogen region and that occupied by the brighter layers of that unknown substance which lies outside it, there was matter, at the sun, the light of which was powerful in its action upon a photographic plate, while it was comparatively powerless to act upon the eye. The corona depicted on the photographic plate was vastly different from the corona seen by the eye, but from a very different cause—one depending upon the condition of our air, or, at all events, of something between us and the moon.

"Now, if we assume that there is something at the sun enveloping the hydrogen, this something will be cooler, and we have now an abundance of laboratory experiments to show that the molecular constitution of the vapours of the same chemical element at different temperatures is vastly different; and, further, that the spectra of these variously constituted molecules are very definite, and, for the same degree of molecular complexity, have a strange family likeness to each other.

"So far as we have gone already, we have never been able to attack those parts of the sun's surroundings where, in consequence of the reduction of temperature, the various affinities of the molecules have begun to come into play, and combinations of molecules with similar or dissimilar molecules must occur.

"As a consequence of the perfect action of dissociation in the lower layers which has apparently reduced the vapours of all the chemical substances present in the sun's atmosphere to their simplest molecular condition, each vapour in this condition thins out, so to speak, in such a manner that everything represented high up in the atmosphere is more strongly represented low down. But though this is true for a state of things where the molecular constitution is of the simplest, it is quite clear that if we assume an exterior cooler region filled with molecules of greater complexity in consequence of a reduced temperature, if we can get at this region observationally we shall find that the spectrum which it gives will be confined to the higher levels, and will not be represented lower down because the compound molecules which produce it will be broken up by the higher temperature of the subjacent regions.

"Now, it looks as if this important and anticipated result has been established. In a telegram addressed to the *Daily News* it is stated that 'the prismatic camera shows the rings with protuberances at the edge of the sun, and at least one more ring towards the ultra-violet without protuberances.' In other words, the molecules which existed higher up, and built up the stratum of the spectrum of which consisted of a ring towards the ultra-violet above the prominence-region, were unrepresented below among the simpler molecules the spectra of which consist of rings extending down to, and actually including, the prominences.

"We have said this much by way of pointing out one

among the many questions on which light may be thrown by the photographs which have been secured in Siam, and which it was hoped would have been duplicated in the Bay of Bengal. As the prismatic camera was the instrument requiring least time for adjustment, so it was the one which could be employed for the longest period during the eclipse. Before and after totality it may have done good service by recording the constitution of the lower part of the sun's atmosphere in a manner which it will not be very difficult to interpret, though certainly the characters will be of the strangest."

ARCTIC GEOLOGY*

III.

Coast of Arctic America.—Melville Peninsula.—Amongst the rock specimens brought home by Dr. Rae, Prof. Tennant recognised gneiss, hornblende slate, and similar metamorphic rocks, a portion probably of the granitic and crystalline rocks described by Sir John Richardson as occupying the central and eastern countries of the Hudson's Bay territory, believed by Sir R. Murchison to belong to the Laurentian system. The latter points out that from the prevalence of a profusion of Upper Silurian corals characteristic of the Niagara and Onondaga limestones (Wenlock or Dudley), the trilobite *Encrinurus punctatus*, and the shell *Pentamerus oblongus*, in the rocks lying on the Laurentian, in the north of the Hudson's Bay territory, and the absence of any traces of Lower Silurian rocks or fossils in the whole of the known polar region, that it is in the highest degree probable that the whole of the country north of the Laurentian Mountains was dry land during the deposition of the Lower Silurian. In the area to the south, and in Europe, and even in the Upper Silurian times, the sea, as evidenced by the presence of *Pentamerus*, was not a deep one, which is borne out by Sir W. Logan's discovery that the Silurian limestones at the head of Lake Temiscamang include enormous blocks of the sandstone on which they rest.†

Boothia.—Chalky limestones occur, but do not contain fossils, as at Prince of Wales Island, where the Esquimaux obtain large quantities of native copper on the shore.

Sir James Ross ‡ describes the River Saumarez, lat. 70, long. 92 W., as never frozen, and gives a sketch showing the gorge 80 feet in depth, excavated in hard trap, in which it runs. In the month of July he found several butterflies living near the coast, including an *Hipparchia*, two species of *Colias*, one being near *C. edusa*, and a *Polyommatus*. In Agnew River he found copper ore.

West Coast of Baffin Sea.—Crystalline rocks extend from Lancaster Sound to Cape Walter Bathurst and Cumberland Sound, with the exception of Cape Durban, where coal has been found by the whalers, a continuation probably of that of Disco; it also occurs at Kingaiti, two degrees south of Durban, as well as pure graphite.§

Arctic Archipelago.—Dr. Haughton, from an examination of the rocks and fossils collected by Sir Leopold M'Clinck from 1849 to 1859, now deposited in the museum of the Royal Dublin Society, was enabled to draw up a geological map of the Arctic Archipelago,|| in which Silurian limestone is shown to occupy nearly all the islands south of Lancaster and Melville Sounds, including the south side of Banks Land, Prince Albert Land, Prince of Wales Land, King William's Island, and Boothia Felix, the central and western area of North Devon, and the whole of Cornwallis Island, &c.; granitoid rocks occurred on either side of Peel Sound, and at Ponds Bay, and

near the mouth of the Fish River; also the eastern coast of North Devon and the opposite side of Baffin Bay, to 77° north latitude.

The lower carboniferous close-grained white sandstone ("Ursa stage" of Heer), with beds of coal, strikes S.W. and N.E. from Baring or Banks Land, where it rests on the Silurian, through Melville Island to Bathurst Island, where it disappears under the carboniferous limestone between Penny Strait and Queen's Channel.

The carboniferous limestone appears to strike nearly east and west; the whole of Prince Patrick Island is composed of it, and the northward portion of Parry Islands and the whole of Grinnell Land; * scattered over the limestone on several points are patches of lias, in which fossils have been found, notably at Intrepid Inlet, Arnott Bay, Bathurst Island, and on Exmouth Island north of Grinnell Land.

North Devon.—From Cape Osborne to Cape Warrender graphic granite occurs, passing into laminated gneiss consisting of black mica and transparent felspar, interstratified with garnetiferous mica-slate, traversed by epidote hornstone overlaid by red sandstone, similar to that of Wolstenholme Sound.

Dr. Sutherland describes the crevasses of the glaciers of Petowak, on the south coast of Jones Sound, as often being filled with mud, which becomes frozen in, and the whole mass breaks off in bergs.

North Somerset.—Granite of grey quartz, red felspar, and green chloritic mica occurs on the west coast. Eastward, the island consists of the Upper Silurian sandstones and limestones, the junction of which occurs in Transition Valley. In Bellot Straits granite and syenite rise to a height of 1,600 feet. The base of the Silurian consists of red sandstone and coarse grit, resembling those of Cape Warrender and Wolstenholme Sound, overlaid by ferruginous limestones with quartz grains, earthy limestones, occasionally cream-coloured, dipping from 0° to 5° to the N.N.W.; a few high cliffs occur, but the country is generally low and terraced, the limestone standing out as steps and buttresses, particularly at Port Leopold, where the alternation of hard limestone and soft shales, so well known in European limestone districts, is well shown in Beechey's sketch, at p. 35 of Parry's First Voyage. Amongst the fossils from Port Leopold Dr. Haughton records *Loxonema M'Clinckii*, and specimens of carnelian and selenite.

Prince of Wales Island.—Eruptive syenite occurs at Cape M'Clure. The western coast consists of Silurian limestone with fossils, overlaid by bright red ferruginous limestones, and a few beds of bright red sandstones, like the Transition Valley sandstone.

Banks Land.—Upper Silurian rocks are succeeded by close-grained sandstone, striking N.E. to E.N.E., of Lower Carboniferous age, and containing thin coal seams, discovered first in Parry Islands by Parry, and afterwards by Austin and Belcher in Melville Island and Bathurst Island. The fossils from this series are similar to those from the Irish Calp series, and from the Eifel. Silicified stems of plants were discovered by M'Clure on the coast of Banks Land, and on those of Wellington Channel by Belcher. The southern entrance to this channel was discovered by Sir Edward Parry in 1819. The lamented Sir John Franklin sailed up it 150 miles in 1845, before being beset with ice at Beechey Island in September 1846.

In Drift on the Coxcomb Range, Banks Land, M'Clure found fine specimens of *Cyprina Islandica*, 500 feet above the sea. In 78° N., Belcher found whale bones on high ground; and marine shells are described by Parry as occurring in clay in the ravines of Byam Martin's Island.

From the coast of Princess Royal Island the Esquimaux procure native copper in large masses. The rocks consist of greyish-yellow sandstone, with *Terebratula aspersa*.

* The north-west corner of North Devon, not the large tract west of Kenedy Channel.

* Continued from p. 469.

† Narrative of Expedition to Shores of Arctic Sea. By John Rae. London, 1852. "Siluria," 5th edit. London, 1872.

‡ Narrative of Second Voyage in search of a N.W. Passage, by Sir James Ross. 1835.

§ Quar. Jour. Geol. Soc., vol. ix.

|| "Voyage of the Fox." Appendix IV. (London, 1850.)